Distance Sensitivity of Rural Telephone Company Transport Networks

Technology White Paper

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This Technology White Paper was prepared at the request of the South Dakota Telecommunications Association (SDTA) in response to the Commission's request for comment in CC Docket No. 01-92.[1] It discusses the costs associated with providing transport of telecommunications services for Rural Local Exchange Carriers (RLECs) from a technical and cost perspective.

Vantage Point Solutions, Inc. (VPS) is a telecommunications engineering and consulting company providing a full range of services including Professional Engineering, Outside Plant Engineering Services, strategic planning, technology evaluations, network architecture design, regulatory expertise, and feasibility studies. VPS is focused on the unique business challenges faced by RLECs. VPS provides Engineering and Outside Plant (OSP) services to many telephone companies in South Dakota and elsewhere.

The authors of this Technology White Paper have over fifty-five (55) years experience in the telecommunications industry, including over forty (40) years of OSP design and construction experience. [2] This Technology White Paper establishes the fact that transport networks, especially rural transport networks, require a significant

[1] Developing a Unified Intercarrier Compensation Regime, *Further Notice of Proposed Rulemaking*, CC Docket No. 01-92 (FCC 05-33) ("FNPRM").
[2] Larry D. Thompson, PE – CEO, Vantage Point Solutions, Tim McEntee, Vice President of Outside Plant Operations, Vantage Point Solutions. See Attached Resumes.

investment by the ILEC. As a general rule, the transport costs increase as the area served becomes more rural.

I. TRANSPORT TECHNOLOGIES

Transport networks involve two basic components; the end office electronics and the actual transmission medium (copper cable, fiber cable, radio frequency, free-space optics, etc.). The central office electronics are used to terminate the transport signal and convert it to a format that is compatible with the other equipment in the central office.

Fifty or more years ago, central office transport networks were based on analog transmission techniques and would often utilize twisted-pair copper OSP cable facilities. In the 1960's telephone companies began utilizing digital techniques for transporting their signals to increase the capacity of their copper networks as well as minimize the effects of noise. Up until the 1980's, transmission technologies for telephone companies primarily used copper OSP cable facilities.

In the 1980's, telephone companies began deploying fiber optic communication networks. Fiber optic networks resulted in increased bandwidth and much longer distances between electronic terminals. Over time, much of the copper cable used for transport was replaced with fiber optic cable. Today, the dominant standard for fiber optic transmission is Synchronous Optical Networks (SONET). Over the last 20 years, the bandwidth available on a typical fiber optic transport network has increased from less than 50 Mbps to 10,000 Mbps.

Fiber optic interexchange cable can either be buried or aerial. In South Dakota, nearly all interexchange cable is now buried. The expected useful life of a cable, either

copper or fiber, is normally 25 to 35 years. Much of the copper and fiber cable that was installed in the 1970's and 1980's is being replaced today. It is important to note that all cables have a limited life expectancy and must be replaced occasionally. This replacement cost is substantial for the RLEC as will be seen in the next section.

The central office transport electronics have a useful life that is much shorter than the OSP cable, often in the range of 5 to 10 years. The life expectancy of transport electronics is often dictated by bandwidth capacity limitations, reliability issues as the electronics age, lack of support from the manufacturer, and/or other cost of ownership issues. The transport network for a RLEC is a significant investment and one that requires substantial recurring investments as the cable and electronics age and as subscriber demands increase.

II. TRANSPORT NETWORK CONSTRUCTION COSTS

The cost for OSP construction can vary dramatically from one location to another due to a variety of factors. Some of these factors include:

- Soil/terrain conditions (rocks and other obstacles)
- Environmental issues (historical sites, endangered plants or animals, etc.)
- Securing rights-of-way (either public or private)
- Local labor costs

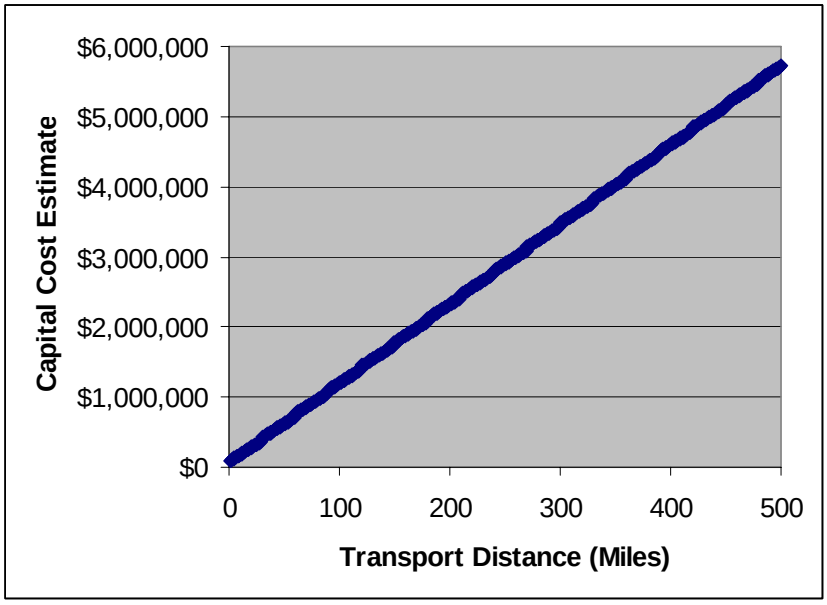
In South Dakota, it is not uncommon for rural OSP construction costs (when including both materials and labor) to range from $6,000 per mile to over $17,000 per mile for large fiber construction projects (50 miles or more) in relatively easy construction corridors. When working in state and national parks or areas with difficult

construction conditions (such as lava flows, rocky areas, or limited rights-of-way), OSP construction costs could be $50,000 per mile or more. In-town construction is often three or four times higher per mile than rural construction.

Fiber optic terminals are required at each end of the fiber cable and often at intermediate points along the route to amplify or process the signal. The installed cost of these terminals is often between $30,000 and $100,000 per location depending upon several factors, such as:

- Redundancy options
- Distance between fiber terminals
- Feature functionality
- Capacity or bandwidth of terminal
- Service interface requirements

Terminals are often placed along the fiber route at a spacing of 20 to 60 miles, depending upon the quality and capability of the fiber cable and fiber terminal. Using an average cost of $10,000 per mile for OSP construction and $40,000 per fiber terminal (spaced at an average distance of 30 miles), the transport capital cost per distance (does not include operational and maintenance costs) can be seen in the following chart.



As one can see, the capital investment in transport could be more than $3,000,000 for a fiber route of only 300 miles when assuming an average OSP construction cost of $10,000 per mile. As mentioned earlier, OSP construction in South Dakota and other rural states could be $50,000 per mile or more in difficult construction areas. This would result in a much higher transport investment than is shown in the previous example. It seems unreasonable to assume that the RLEC would have to provide this transport to another carrier without that carrier paying for the use and bearing their fair share. Any such requirement would place RLECs at a significant competitive disadvantage compared to those that would obtain the free use of their networks. Further, with no incentive to invest, RLECs would reduce their network investments and their rural networks and service to rural customers would decline over time.

III. RURAL TRANSPORT CHALLENGES

South Dakota is a rural state. The service area of the South Dakota RLECs covers over 60,000 square miles and has approximately 145,000 access lines. The RLECs provide service over almost 80% of the total land area in South Dakota, yet serve only 35% of the total South Dakota access lines. The RLECs in South Dakota average 2.4 access lines per square mile. West River Cooperative Telephone Company, headquartered in Bison, serves 5,769.5 square miles with a total of 3,831 access lines – only 0.66 access lines per square mile. In comparison, the state of New Jersey has 8,722 square miles with almost 7,000,000 access lines or approximately 800 access lines per square mile. Washington DC has 68.25 square miles with 925,000 access lines or over 13,000 access lines per square mile.

Because of South Dakota's large geographic distances, the South Dakota RLECs must make a significant investment in transport to serve their customers. Many of the South Dakota RLECs have in part addressed the problems created by these large geographic distances by jointly financing and constructing a fiber optic backbone network in South Dakota, named SDN Communications. This joint effort has helped to address at least some of the transport challenges facing the South Dakota RLECs. Jointly, they were able to construct a 2,550 mile fiber network. This network provides transport between 21 main network nodes throughout the state and the RLEC-owned centralized equal access tandem in Sioux Falls. Using $10,000 per mile as the average rural construction cost for fiber, the cost of the fiber optic cable is estimated to be $25,500,000. The electronic investment for the network has been $14,500,000 over the last 6 years. This portion of the RLEC transport network capital investment alone totals

$40,000,000, without including the ongoing operational and maintenance costs for the network, required to serve their 145,000 ILEC customers.

South Dakota RLECs have also invested in their own local transport networks, providing connections to the backbone network of SDN Communications and other network providers. These RLECs currently operate more than 200 central offices and these offices are interconnected with transport facilities and have 41 toll connection points. The interconnection facilities between these central offices result in an additional 5,000 to 6,000 airline miles of intercompany and intracompany transport. The actual miles of construction would be considerably higher. Vantage Point estimates that the OSP investment alone would be significantly more than $60,000,000 to simply connect the RLEC end offices to their toll connection points. This investment is in addition to what was required for the SDN Communications backbone fiber network as discussed previously. A diagram showing distances between the RLEC end offices and their toll connection points as well as the distances between these toll connection points and the South Dakota Network tandem is attached as Exhibit 1. This exhibit also shows the geographic area of South Dakota compared to Washington D.C., Delaware, and Rhode Island. Clearly, as shown by Exhibit 1, rural states such as South Dakota face a significant challenge with regard to providing numerous miles of transport that are required in sparsely populated areas.[3]

[3] Note that Exhibit 1 is not intended to show fiber route miles or network architecture. The intent of Exhibit 1 is to show the large geographic distances between the RLEC end offices and their shared tandem switch.

IV. SUMMARY

The cost of deploying a transport network can be significant, especially in rural states such as South Dakota. Through a cooperative effort, the RLECs in South Dakota have been able to build a joint backbone network which has reduced the transport costs of a portion of their network. The initial investment in this backbone network as well as their company-specific intracompany network has been substantial. The ongoing costs will also be significant as fiber cables and electronics reach the end of their useful life and require replacement.

With time, electronics will continue to improve to provide additional features and increased bandwidth to meet increasing user demands. The costs of OSP construction will likely continue to rise as rights-of-way become more costly to secure and environmental issues and government regulations continue to become more onerous. As the RLEC networks continue to evolve, it is likely that the costs will also increase, not decrease.

Contrary to the commonly held perception, advanced services, including VoIP, will not reduce the required investment in the transport networks, but will likely increase that investment. The network will need to adapt to new protocols and increased bandwidth requirements which will result in future investments. As has been the case historically, these transport networks will have to be upgraded and possibly replaced with new transport networks in order to handle the customer demands of the future.

As shown in this white paper, transport costs for the RLECs in South Dakota and elsewhere can be enormous. Much of these costs are associated with OSP construction, which will likely increase with time rather than decrease. These RLECs will have to

continue to invest in their transport networks if they are to meet the customer demands of the future. It is unreasonable to assume that the RLECs must provide this transport network to others for free. It is equally unreasonable to assume that these transport costs could be borne by the few customers that the RLECs serve.

About the Authors

Larry D. Thompson, PE - CEO

Larry has been an active participant in the telecommunications industry since 1985. He received a Bachelors of Arts in Physics (1983) from William Jewell College, a Bachelors of Science in Electrical Engineering (1985) from the University of Kansas, and a Masters of Science in Electrical and Computer Engineering (1986) from the University of Kansas. He is uniquely qualified to lead Vantage Point Solutions in the ever-evolving telecommunications industry. Larry has a proven track record in both the technical and leadership challenges of the business. Prior to Vantage Point Solutions, Larry was General Manager for the Telecom Consulting and Engineering (TCE) Business Unit of Martin Group.

From a technical standpoint, Larry has expertise in the design and implementation of voice, data, and video networks. Larry was lead engineer on the some of the largest Digital Subscriber Line (DSL) video deployments in ILEC service areas. In addition, Larry has architected and optimized many large voice, data, and video networks with a focus on throughput and security.

Larry is a registered Professional Engineer (PE) in the states of Colorado, Georgia, Idaho, Iowa, Indiana, Michigan, Minnesota, Missouri, Nebraska, New York, Ohio, South Dakota, Utah, Wisconsin, and Wyoming. He is a member of several engineering, math, and physics societies, including Eta Kappa Nu, Tau Beta Pi, Sigma Pi Sigma, and Kappa Mu Epsilon.

Tim McEntee - Vice President of Outside Plant Operations

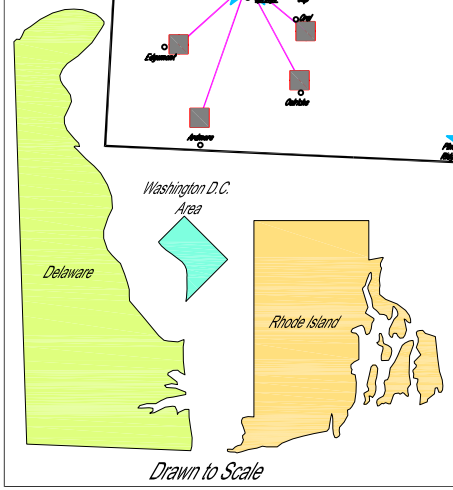
Tim has specialized in Outside Plant Operations his entire telecommunications career. He has over 35 years of experience and supervises Resident Engineers, staking, contract bidding, and pre-construction conferences. Tim is also responsible for the close out process on all Outside Plant, Special Equipment, and Central Office Equipment contracts.

Throughout his career, Tim has been sought out as a valued consultant to numerous state and other governmental agencies. He has been involved in over $900 Million of Outside Plant projects consisting of over 45,000 miles of copper distribution facilities and 10,000 miles of fiber optic cable. Tim has also been an innovative resource for the implementation of automated mapping, staking, and estimating tools into the Outside Plant process. The use of these automated tools allows Vantage Point Solutions to deliver a polished, professional end product. Prior to Vantage Point Solutions, Tim was Director of Outside Plant Operations for the TCE Business Unit at Martin Group.

Tim has received specialized training from a variety of sources such as the Association of Communications Engineers (ACE), United State Department of Agriculture (USDA) Rural Utilities Service (RUS), Occupational Safety and Health Administration (OSHA), and numerous other seminars, workshops, and demonstrations.

South Dakota Rural Local Exchange Carriers

Exhibit 1



- Washington D.C. Area - 68.25 Sq. Miles
  Pop. = 572,059
  Pop. Density = 8,382 / Sq. Mi.

- Rhode Island Area - 1545 Sq. Miles
  Pop. = 1,048,329
  Pop. Density = 679 / Sq. Mi.

- Delaware Area - 1,954 Sq. Miles
  Pop. = 783,600
  Pop. Density = 401 / Sq. Mi.

- South Dakota Area - 77,121 Sq. Miles
  Pop. = 754,844
  Pop. Density = 10 / Sq. Mi.

- SDN Centralized Equal Access Tandem
- Toll Connection Points
- End Office
- Transport between CEA Tandem and Toll Connection Points *
- Transport between Toll Connections Points and Rural Telephone Company End Offices *

* Actual route not shown

SDN COMMUNICATIONS

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